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DYNAMIC PROPERTIES OF MATERIALS

PART II. ALUMINUM ALLOYS

BOSTON UNIVERSITY

PREPARED FOR

ARMY MATERIALS AND MECHANICS RESEARCH CENTER

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A literature survey on the mechanical properties of aluminum alloys under dynamic loadings has been made. The experimental data showing the variation of yield, ultimate strengths and elongation with strain rate and temperature are compiled and tabulated. The range of strain rate included in this report is from 10^{-5} in/in/sec to 10^{4} in/in/sec, while the temperature range is from -300°F to 900°F. The variations of yield and ultimate

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strengths are plotted for 6061 and 7075 aluminum alloys.

It is shown that both the yield and ultimate strengths are higher under dynamic loads than under static loads. However, the aluminum alloys are not as strongly affected by strain rate as polymers and steels. It is also shown that the yield and ultimate strengths decrease with an increase of temperature.

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FOREWORD

This report describes the work performed by the Department of Aerospace Engineering, Boston University, for the Army Materials and Mechanics Research Center (AMMRC), Watertown, Massachusetts, under Contract No. DAAG-46-73-C-0181. The Contracting Officer Representative at AMMRC was Dr. S. C. Chou. The program was supervised by Professor M. M. Chen at Boston University.

Dynamic Properties of Aluminum Alloys

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ABSTRACT

A literature survey on the mechanical properties of aluminum alloys under dynamic loadings has been made. The experimental data showing the variation of yield, ultimate strengths and elongation with strain rate and temperature are compiled and tabulated. The range of strain rate included in this report is from 10^{-5} in/in/sec to 10^{4} in/in/sec, while the temperature range is from -300°F to 900°F. The variations of yield and ultimate strengths are plotted for 6061 and 7075 aluminum alloys.

It is shown that both the yield and ultimate strengths are higher under dynamic loads than under static loads. However, the aluminum alloys are not as strongly affected by strain rate as polymers and steels. It is also shown that the yield and ultimate strengths decrease with an increase of temperature.

INTRODUCTION

The mechanical behavior of aluminum alloys under dynamic loading conditions has been the subject of many researchers. The behavior has generally been studied in terms of the variance of yield and ultimate strengths with strain rate and temperatures. The dynamic properties presented in this report are based on a literature survey of experimental data for aluminum alloys. The data is usually limited to specific strain-rate ranges of particular interest. To cover a large range of strain rates, several test setups have been used by investigators. Both tension, compression and torsion results are included in this survey.

In this study, the elongation is reported as the percentage of elongation at break. In the case of compression, the sign of elongation in the tables should be considered as negative. All the pertinent information of this survey is shown in the List of Investigations. The methods of measuring strain rate are shown in the Remarks column for each reference. In some reports, the strain rates were calculated from the cross-head speed, in which the strain rate is obtained by dividing the cross-head speed by the gage length.

The yield strength of aluminum alloys is usually determined by one of the following two methods:

(1) Offset Method - In this method, it is necessary to secure the data for a stress-strain diagram. On the stress-strain diagram (See Fig. A), lay off OM equal to 0.2%, and draw MN parallel to OA which intersects the stress-strain curve at point r. The stress at r is called yield stress.

(2) <u>Total-Extension-Under-Load Method</u> - In this method, it is required to apply the load until a specified extension, which corresponds to a strain of 0.5%, is reached. The stress corresponding to this point is the yield point (see Fig. B).

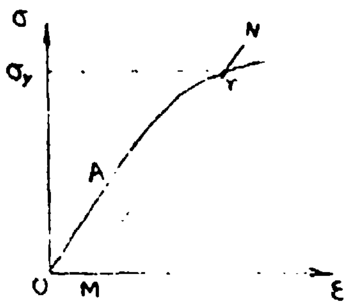

Fig. A

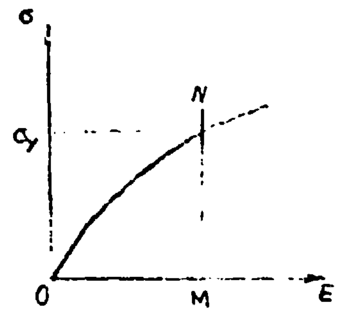

Fig. B

The ultimate strength is calculated by dividing the maximum load carried by the specimen during tension or compression tests by the original cross-section area of the specimen.

It is noticed that most of the experiments were done in the 1960's and they were carried out at room temperature. The strain rate in the survey ranges from 10^{-5} to 10^{4} sec^{-1}. The temperature range varies from -320°F to 932°F, although most of the data were obtained at room temperature.

This document should serve as an information source for design and for future research work.

RESULTS AND DISCUSSION

The stress-strain curves obtained for aluminum alloys were monotonically increasing and showed no unusual features. The yielding point was not apparent for most aluminum alloys.

The strain rate has a relatively minor effect on the yield strength at room temperature (see e.g., Fig. 1). At higher temperatures, however, the effect of the strain rate on the yield strength becomes more pronounced (e.g., Fig. 2).

It is observed that high rates of strain hardening are found at low temperature, while little or no strain hardening is found at higher temperatures. In the intermediate temperature range, the slope of the stress-strain curve is strongly dependent upon the strain rate.

In general, the yield strength and ultimate strength varies linearly with $\log \dot{\varepsilon}$, and the slope of the variation is larger at higher temperatures (see Figs. 2 and 3). The difference in the slopes of these two parameters indicates the degree of strain hardening of the material.

More recently, the concept of flow stress has been used to represent the dynamic property of aluminum alloys. For low temperature ranges, the relationship of flow stress and strain rate can be described as (see e.g., D-1, H-4)*:

$$\sigma_0 = C \dot{\varepsilon}^m \tag{1}$$

where σ_0 is the stress for a given strain, $\dot{\varepsilon}$ is the strain rate, C = constant for each temperature and m = the strain rate sensitivity coefficient for each temperature.

At high temperatures, the relationship between the flow stress, σ_0 , strain rate, $\dot{\varepsilon}$, and temperature, T, can be

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*Letter and number in parenthesis indicates the reference number.

represented by

$$\sigma_0 = f(\dot{\varepsilon} \exp \Delta H/\bar{R}T) \tag{2}$$

where ΔH is the apparent activation energy for deformation whieh can be considered as a constant in some temperature range, and $\bar{R}$ is the universal gas constant. It is felt that more research work is needed in this area.

LIST OF INVESTIGATIONS

Material	T(°F)	$\dot{\varepsilon}$(/sec)	Type of Test	Ref.	Date
1100	392~1112	$1\times10^{-2} \sim 1\times10^{2}$	torsion	B-3	1972
1100-0	room	$1\times10^{-4} \sim 8.9\times10^{2}$	torsion	F-2	1972
1100-0	68~392	$9.5\times10^{-2} \sim 2.13\times10^{2}$	compression	H-3&H-4	1967, 1970
1100-0	room	$1\times10^{-4} \sim 2.5\times10^{1}$	torsion	N-2	1971
1100	200~800	$0 \sim 1\times10^{3}$	tension	S-4	1969
Al-2S	room	$0,\ 3.75\times10^{1} \sim 3\times10^{2}$	tension	C-3	1950
Al 2S	room~1112	$9\times10^{-7} \sim 1\times10^{3}$	tension	N-1	1941
Pure Al	482~1022	$6.6\times10^{-2} \sim 2.2\times10^{3}$	compression	S-1	1971
99.99% Al	room	$0,\ 2.66\times10^{3}$	compression	J-1	1963
Commercial Pure Al	572~932	$1\times10^{0} \sim 3\times10^{1}$	compression	A-2	1959
Commercial Purity Al	-310~1022	4.38×10^{0}	compression	A-1	1954-5
S.P. Al	392~1112	$4\times10^{-1} \sim 3.11\times10^{2}$	compression	B-1	1963-6
Super-Purity Al	932	$4\times10^{-1} \sim 3.11\times10^{2}$	compression	B-2	1964
Commercial Purity Al	73.4	$0 \sim 1\times10^{-2}$	tension	B-4	1967
Al	room	$0,\ 1.32\times10^{2}$	tension	C-1	1938
Al	room	$0,\ 1.8\times10^{3}$	tension	C-2	1942
Super-Pure Al	383~896	5×10^{-1}	torsion	O-1	1960
7075-0	77~874.4	$2.5\times10^{-5} \sim 5\times10^{-1}$	tension	D-1	1968
7075-0	room	$2.5\times10^{-3} \sim 6\times10^{2}$	compression	H-6	1967
7075-0	room	$2.7\times10^{-5} \sim 6.7\times10^{1}$	tension	S-3	1960
Al-5.7% Zn	752~1022	$1\times10^{-1} \sim 3.11\times10^{2}$	compression	B-1	1963-6
Al-Cu-Si-Mg	572~842	$1\times10^{0} \sim 3\times10^{1}$	compression	A-2	1959-6
7178-T651	room	$1.7\times10^{-4},\ 1.92\times10^{2}$	tension	S-2	1963
7178-T6	room	$1.7\times10^{-4},\ 1.92\times10^{2}$	tension	S-2	1963
5456-0	room	$3.1\times10^{-5} \sim 7\times10^{1}$	tension	S-3	1960
5456-H321	room	$1.7\times10^{-4},\ 1.92\times10^{2}$	tension	S-2	1963
5456-H343	room	$1.7\times10^{-4},\ 1.92\times10^{2}$	tension	S-2	1963
6351-T51	room	$1\times10^{-4} \sim 1\times10^{3}$	tension	L-1	1971
Al-Si-Mg	572~1022	$1 \sim 3\times10^{1}$	compression	A-2	1959-6
5454-0	room	$1\times10^{-4} \sim 9.8\times10^{2}$	tension	L-1	1971

Material	T(°F)	(/sec)	Type of Test	Ref.	Date
5454-H34	room	$9.9\times10^{-4}\sim1.02\times10^{3}$	tension	L-1	1971
Al-2 1/4% Mg.	572~932	$1\sim3\times10^{1}$	compression	A-2	1959-60
Al-5% Mg.	572~932	$1\sim3\times10^{1}$	compression	A-2	1959-60
RR77	room	$1\times10^{-3}\sim1.75\times10^{3}$	tension	H-1	1960
Al-Mn	572~1022	$1\sim3\times10^{1}$	compression	A-2	1959-60
5154-0	room	$4.1\times10^{-5}\sim4\times10^{1}$	tension	S-3	1960
2024-0	-320~930	$1\times10^{-3}\sim4\times10^{-1}$	torsion	F-1	1959
2024-T4	room	$1.7\times10^{-4},1.92\times10^{2}$	tension	S-2	1963
2024-T4	room	$0,\ 6\times10^{4}$	tension	C-4	1958
2024	200~600	$0\sim1\times10^{3}$	tension	S-4	1969
7075-T6	room	$0,\ 6\times10^{4}$	tension	C-4	1958
7075-T6	75~600	$3\times10^{-3}\sim1\times10^{1}$	tension	G-1	1966
7075-T6	room	$0,\ 6.6\times10^{3}$	compression	J-1	1963
7075-T6	80~600	$5\times10^{-5},1\times10^{0}$	tension	K-1	1961
7075-T6	room	$3\times10^{-2}\sim5.6\times10^{2}$	compression	M-1	1966
7075-T6	room	$1.9\times10^{-5}\sim4.3\times10^{1}$	tension	S-3	1960
7075-T651	72~550	$2\times10^{-3}\sim1\times10^{3}$	compression	M-2	1969
6061-T6	room	$0\sim2.26\times10^{4}$	tension	A-3	1959
6061-T6	75~700	$1\times10^{-5}\sim7\times10^{2}$	tension	H-5	1966
6061-T6	room	8×10^{-4}	tension	J-2	1972
6061-T6	72~600	$1\times10^{-3}\sim1.8\times10^{1}$	tension	G-1	1966
6061-T6	room	$1.7\times10^{-4}\sim1.92\times10^{2}$	tension	S-2	1963
6061-T6	room	$1.8\times10^{-5}\sim6.9\times10^{1}$	tension	S-3	1960
6061-T6	room	$9\times10^{-3}\sim9.1\times10^{2}$	compression	M-1	1966
6061	392~932	$1\times10^{-2}\sim1\times10^{2}$	torsion	B-3	1972
6061-0	room	$3.4\times10^{-5}\sim8\times10^{1}$	tension	S-3	1960
6061-T651	room	$1\times10^{-4}\sim1\times10^{3}$	tension	L-1	1971
Al-2017	392~932	$1\times10^{-2}\sim1\times10^{2}$	torsion	B-3	1972
24S-T	room	$0,1.77\times10^{3}$	tension	C-2	1942
24S-T Al	room	$0,3.75\times10^{1}\sim3\times10^{2}$	tension	C-3	1950
24S Annealed	room	$0,3.75\times10^{1}\sim3\times10^{2}$	tension	C-3	1950
Al-4.2%Cu	572~932	$4\times10^{-1}\sim3.11\times10^{2}$	compression	B-1	1963-64
Al-Cu4-Mg1	-103,68	$1\times10^{-3}\sim1\times10^{2}$	tension	H-2	1972
2014-F	room	$0,6\times10^{4}$	tension	C-4	1958
HE15WP Al	room	$0,5\times10^{2},1\times10^{3}$	torsion	N-3	1972

TABLE 1 - DYNAMIC PROPERTIES OF Al-1100 OR EQUIVALENCE

Material: Al-1100, Si 0.32, Fe 0.70, Cu 0.20, Mn 0.05, Mg < 0.01, Cr < 0.01, Zn 0.10, Ti < 0.01, Al Bal.

T(°F)	$\dot{\varepsilon}$(/sec)	σ_Y(psi)	σ_u(psi)	Elong.(%)	Ref.	Remarks
392	1×10^{-2}		10100		B-3 Torsion	Read from (σ, ε) curves, 0.2% offs for σ_Y effective stress Strai[illegible] [illegible] strain r 1 hr. at 662°F air cooled to am- bient temperature
	1×10^{-1}		11500			
	1.3×10^{0}		14100			
	8×10^{0}		15000			
	1×10^{2}		16650			
572	1×10^{-2}		6000			
	1×10^{-1}		7700			
	1.3×10^{0}		9500			
	8×10^{0}		10500			
	1×10^{2}		12600			
752	1×10^{-2}		3460			
	1×10^{-1}		4110			
	1.3×10^{0}		5340			
	8×10^{0}	4880	7250			
	1×10^{2}	5500	8750			
932	1×10^{-2}	1630	1750			
	1×10^{-1}	2000	2440			
	1.3×10^{0}	2550	4440			
	8×10^{0}	3250	5600			
	1×10^{2}	3880	5600			
1112	1×10^{-2}	810	880			
	1×10^{-1}	1000	1250			
	1.3×10^{0}	1690	2040			
	8×10^{0}	2500	3010			
	1×10^{2}	3000	4610			

Material: Al-1100-0

room	1×10^{-4}		7400	18.8	F-2 Torsion	Annealed for 1 1/2 hrs. at 650°F and furnace cooled
	8.5×10^{2}	2530	5870	4.5		
	8.7×10^{2}	2600	6000	4.7		
	8.9×10^{2}	2700	5940	5.0		

T(°F)	$\dot{\epsilon}$(/sec)	σ_Y(psi)	σ_u(psi)	Elong.(%)	Ref.	Remarks

Material: Al-1100-0

T(°F)	$\dot{\epsilon}$(/sec)	σ_Y(psi)	σ_u(psi)	Elong.(%)	Ref.	Remarks
68	1.35×10^{-1}	19700			H-3	Read from (σ_Y , $\dot{\epsilon}$) curves
	3.6×10^{0}	20600			& H-4	
	1.1×10	19900			Comp.	
	3.9×10	20700				
	1.16×10^{2}	19200				
	2.13×10^{2}	20600				
134.6	1×10^{-1}	18200				
	1.1×10^{0}	16900				
	2.14×10	19700				
	1×10^{2}	18000				
	2.1×10^{2}	20900				
392	9.5×10^{-2}	14200				
	7.7×10^{-1}	15000				
	1.2×10^{0}	15000				
	1.17×10^{1}	15900				
	9.2×10^{1}	17600				
	1.16×10^{2}	16900				

Material: Al-1100-0

T(°F)	$\dot{\epsilon}$(/sec)	σ_Y(psi)	σ_u(psi)	Elong.(%)	Ref.	Remarks
room	1×10^{-4}	2400			N-2 Torsion	0.5% strain for σ_Y, read from (σ, ϵ) curves, annealed at 650°F for 1 hr and furnace cooled
	1×10^{-3}	2500				
	1×10^{-2}	2700				
	2.5×10^{1}	2600				

Material: Al-2.5, 99.9% min normal

T(°F)	$\dot{\epsilon}$(/sec)	σ_Y(psi)	σ_u(psi)	Elong.(%)	Ref.	Remarks
room	0		17200	4.6	C-3 Tension	Al-1100, 1/2 hard
	3.75×10^{1} $\sim3\times10^{2}$		22100	17.		
	0.		8700	23.		Al-1100 Annealed 720°F
	3.75×10^{1} $\sim3\times10^{2}$		11600	30.		

Material: Al-1100

T(°F)	$\dot{\epsilon}$(/sec)	σ_Y(psi)	σ_u(psi)	Elong.(%)	Ref.	Remarks
200	0		9400		S-4 Tension	Annealed 800°F for 3 min.

T(°F)	$\dot{\epsilon}$(/sec)	σ_y(psi)	σ_u(psi)	Elong.(%)	Ref.	Remarks
	$1x10^{2}$ ~$1x10^{3}$		10800			
350	0		4500			
	$1x10^{2}$ ~$1x10^{3}$		7800			
550	0		2700			
	$1x10^{2}$ ~$1x10^{3}$		6700			
800	0		1800			
	$1x10^{2}$ ~$1x10^{3}$		4800			

Material: Al-2.5

T(°F)	$\dot{\epsilon}$(/sec)	σ_y(psi)	σ_u(psi)	Elong.(%)	Ref.	Remarks
room	$9x10^{-7}$		10960		N-1 Tension	Annealed 2hrs. a 752°F in vacuum Read from (σ, ϵ curves
	$3.4x10^{-5}$		11350			
	$9x10^{-4}$		11540			
	$5.5x10^{-1}$		12540			
	$1x10^{2}$		15580			
	$5.5x10^{2}$		16230			
	$1x10^{3}$		16920			
392	$3.4x10^{-5}$		4620			
	$1x10^{-2}$		6920			
	$1x10^{2}$		11200			
	$5.5x10^{2}$		12300			
	$1x10^{3}$		12700			
752	$9x10^{-4}$		1210			
	$5.5x10^{-1}$		3650			
	$1x10^{2}$		6540			
	$5.5x10^{2}$		8080			
	$1x10^{3}$		8650			
1112	$9x10^{-4}$		440			
	$5.5x10^{-1}$		1540			
	$1x10^{2}$		4420			
	$5.5x10^{2}$		5500			
	$1x10^{3}$		6200			
room	0	20000	20000	14.8	C-2 Tension	Strain rate = sp /gage length condition unknow
	$1.8x10^{2}$	16950	21000	22.2		

T(°F)	$\dot{\epsilon}$ (/sec)	σ_y (psi)	σ_u (psi)	Elong(%)	Ref.	Remarks
	4.2×10^{2}	17400	22170	25.3		
	7.2×10^{2}	22430	25830	25.3		
	1.08×10^{3}	27570	22200	28.1		
	1.44×10^{3}	29000	22000	24.3		
	1.8×10^{3}	29650	23150	26.3		

Material: Pure Al

482	6.6×10^{-2}		6640		S-1 Comp.	Read from (σ, ϵ) curves
	5.2×10^{2}		16200			
	5.4×10^{2}		16600			
	1.2×10^{3}		16800			
	1.9×10^{3}		17100			
	2.2×10^{3}		17500			
662	6.6×10^{-2}		4270			
	5.2×10^{2}		12000			
	7.4×10^{2}		12300			
	1.2×10^{3}		12600			
	1.9×10^{3}		12900			
	2.2×10^{3}		13300			
842	6.6×10^{-2}		2950			
	5.2×10^{2}		8840			
	7.4×10^{2}		9040			
	1.2×10^{3}		9400			
	1.9×10^{3}		9540			
	2.2×10^{3}		9900			
1022	6.6×10^{-2}		2000			
	5.2×10^{2}		6600			
	7.4×10^{2}		6740			
	1.2×10^{3}		7100			
	1.9×10^{3}		7300			
	2.2×10^{3}		7540			

Material: 99.99%Al

room	0	3000			J-1 Comp.	Annealed to 2900psi yield Read from (σ, $\dot{\epsilon}$) curve
	2.66×10^{3}	6000				

T(°F)	$\dot{\varepsilon}$(/sec)	σ_Y(psi)	σ_U(psi)	Elong.(%)	Ref.	Remarks
Material: Al						
room	0	15920	18920	15.1	C-1 Tension	Strain rate = spe /gage length
	1.32×10^{2}	24240	25030	24.6		
Material: Commercial Purity Al ; Cu 0.01, Si 0.02, Mn 0.02, Fe 0.46, Zn 0.01, Al. Bal.						
-310	4.38×10^{0}		34290		A-1 Comp.	Annealed for 1 hr at 752°F Read from (σ, ε) curves
662	4.38×10^{0}		8460			
842	4.38×10^{0}		5000			
1022	4.38×10^{0}		3080			
Material: Commercial Pure Al ; Cu 0.02, Si 0.12, Fe 0.31, Al Bal.						
572	1×10^{0}		7400		A-2 Comp.	Read from (σ, ε) curves
	1×10^{1}		9000			
	2×10^{1}		10000			
	3×10^{1}		10400			
752	1×10^{0}		4600			
	1×10^{1}		5600			
	2×10^{1}		6400			
	3×10^{1}		7000			
932	1×10^{0}		3200			
	1×10^{1}		3800			
	2×10^{1}		4400			
	3×10^{1}		5000			
Material: S.P. Al						
932	4×10^{-1}		2170		B-2 Comp.	Read from (σ, ε) curves
	2×10^{0}		2830			
	9×10^{0}		3750			
	4.1×10^{1}		4500			
	1.01×10^{2}		5660			
	2.03×10^{2}		6330			
	3.11×10^{2}		6670			

T(°F)	$\dot{\varepsilon}$(/sec)	σ_Y(psi)	σ_u(psi)	Elong.(%)	Ref.	Remarks
Material: S.P. Al						
383	5×10^{-1}	3000	8300		O-1	Yielding at 0.2%
536	5×10^{-1}	1470	5470		Torsion	offset
734	5×10^{-1}	1180	3250			Read from (σ,ε) curves
896	5×10^{-1}	940	1530			
Material: S.P. Al; Cu 0.0017, Si 0.0026, Fe 0.0033, Mn 0.006, Al 99.99						
392	4×10^{-1}		9700		B-1	Heat treated for
	9×10^{0}		10450		Comp.	hr. at 1112°F
	1.01×10^{2}		11300			Read from (σ,ε) curves
	3.11×10^{2}		16000			
752	4×10^{-1}		3850			
	9×10^{0}		5300			
	1.01×10^{2}		8050			
	3.11×10^{2}		9150			
932	4×10^{-1}		2020			
	2×10^{0}		3000			
	9×10^{0}		3900			
	4.1×10^{1}		4060			
	1.01×10^{2}		5080			
	3.11×10^{3}		6900			
1022	4×10^{-1}		1250			
	2×10^{0}		1750			
	9×10^{0}		2020			
	4.1×10^{1}		3500			
	1.01×10^{2}		4000			
	3.11×10^{2}		5000			
1112	4×10^{-1}		1000			
	2×10^{0}		1500			
	9×10^{0}		2240			
	4.1×10^{1}		2900			
	1.01×10^{2}		3450			
	2.03×10^{2}		4000			
	3.11×10^{2}		4500			

TABLE 2 - DYNAMIC PROPERTIES OF Al-6061

Material: Al-6061-T6

T(°F)	$\dot{\varepsilon}$(/sec)	σ_Y(psi)	σ_U(psi)	Elong.(%)	Ref.	Remarks
room	0		50000	25.5	A-3 Tension	Strain Rate at fracture Impact tester Read from table True stress
	4.48×10^{3}		54000	19.9		
	5.13×10^{3}		64000	20.7		
	5.85×10^{3}		59000	20.0		
	6.89×10^{3}		58000	20.4		
	7.13×10^{3}			20.5		
	9.55×10^{3}		61000	21.8		
	1×10^{4}		69000	20.3		
	1.54×10^{4}		58000	20.3		
	2.26×10^{4}		68000	25.5		
75	4.8×10^{-5}	37900	43800	21.0	H-5 Tension	σ_Y at 0.2% offset Method 211.1 Type R3 of Federal Test Method Standard No. 151a Dynapak metal working machine, strains and strain rate were calculated from the output of a velocity transducer attached to the specimen's threaded ends. Read from (σ, $\dot{\varepsilon}$) curve and table.
	3×10^{-2}		44000	21.0		
	7×10^{0}		46000	19.0		
	1.9×10^{1}		48000	17.0		
	2.8×10^{1}	45050	52000	17.8		
	4.4×10^{1}		51000	16.5		
	6.5×10^{1}	48500	51000	19.0		
	7.2×10^{1}		53000	17.5		
	1.1×10^{2}		54000	15.5		
500	1×10^{-5}	15100	19000	16.0		
	3×10^{-2}		27600	13.0		
	8×10^{0}		33000	13.0		
	1.8×10^{1}	33100	37000	14.0		
	5.8×10^{1}		43000	15.5		
	7.5×10^{1}		44000	16.0		
	1.3×10^{2}	41850	46000	15.0		
00	1×10^{-5}	4000	5500	15.0		
	3×10^{-5}		9500	15.0		
	1.3×10^{1}		25000	13.0		
	2.3×10^{1}	28250	30000	14.5		
	2.8×10^{1}		28000			
	5.4×10^{1}	31600	33000	12.5		
	8.2×10^{1}		34000	14.0		

T(°F)	$\dot{\varepsilon}$ (/sec)	σ_Y(psi)	σ_u(psi)	Elong.(%)	Ref.	Remarks
72	2×10^{-3}	43500	50000		G-1 Tension	Read from (σ, ε) curves
	1.8×10^{1}	44000	50000			
300	1×10^{-3}	39300	43000			
	9×10^{0}	43000	45600			
600	2×10^{-3}	21000	21500			
	1×10^{2}	28400	29000			
room	8×10^{-4}	41350	45150	17.0	J-2 Tension	thickness = 0.125
	8×10^{-4}	40700	45100	17.25	J-2 Tension	thickness = 0.091
	8×10^{-4}	39350	44200	16.65	J-2 Tension	thickness = 0.08
room	1.7×10^{-4}	41670	48250	15.0	S-2 Tension	Read from (σ_Y, $\dot{\varepsilon}$) curve
	1.7×10^{-3}	41930	48080	15.0		
	1.7×10^{-2}	42750	48330	15.0		
	1.7×10^{-1}	43470	48300	15.0		
	1.45×10^{2}	46670	56670	16.7		
	1.92×10^{2}	47570	53500	17.5		
room	1.8×10^{-5}	43300	48400	8.0	S-3 Tension	Normal strain rate
	3.7×10^{-4}	41800	48600	8.9		Charpy impact testing machine
	5.3×10^{-2}	44700	49000	12.0		Read from table
	6.9×10^{1}	45000	51000	12.4		
room	9×10^{-3} ~9.1×10^{2}	42260			M-1 Comp.	σ_Y at 0.2% offset Read from (σ, ε) curve Medium strain-rate machine & split Hopkinson bar apparatus

Material: Al-6061; Si 0.65, Fe 0.73, Cu 0.16, Mn 0.15, Mg 0.92, Cr 0.22, Zn 0.35, Ti 0.15, Al Bal.

T(°F)	$\dot{\varepsilon}$ (/sec)	σ_Y(psi)	σ_u(psi)	Elong.(%)	Ref.	Remarks
392	1×10^{-2}	15620	20000	284	B-3 Torsion	σ_Y at 0.2% offset Read from (σ, ε) curves
	1×10^{-1}	16560	20740	285		Effective stress, strain and strain rate - 2 hrs. at 752°F then furnace cooled at 86°F/hr. to 500°F and air cooled to ambient temperature
	1.3×10^{0}	18130	22750	277		
	8	19060	24390	245		
	1×10^{2}	20000	25630	214		
572	1×10^{-2}	7190	8050			
	1×10^{-1}	8750	10380			
	1.3×10^{0}	10000	11980			
	8×10^{0}	10630	13350			
	1×10^{2}	12060	15630	272		

T(°F)	$\dot{\varepsilon}$ (/sec)	σ_Y(psi)	σ_u(psi)	Elong.(%)	Ref.	Remarks
662	$1x10^{-2}$	3000	4920			
	$1x10^{-1}$	4600	6300			
	$1.3x10^{0}$	5000	8000			
	$8x10^{0}$	6750	9000			
	$1x10^{2}$	7200	11500			
752	$1x10^{-2}$	2750	3320			
	$1x10^{-1}$	4000	4750			
	$1.3x10^{0}$	4920	6000			
	$8x10^{0}$	5600	7150			
	$1x10^{2}$	8000	9400			
842	$1x10^{-2}$	2000	3000			
	$1x10^{-1}$	3150	4000			
	$1.3x10^{0}$	4750	5250			
	$8x10^{0}$	5330	6050			
	$1x10^{2}$	6000	8400			
932	$1x10^{-2}$	1300	2000			
	$1x10^{-1}$	2000	3130			
	$1.3x10^{0}$	3300	4040			
	$8x10^{0}$	5200	5750			
	$1x10^{2}$	6000	7500			

Material: Al-6061-0

room	$3.4x10^{-5}$	7700	19800	23.5	S-3 Tension	Normal strain rate Charpy impact testing machine Read from table
	$5.6x10^{-4}$	9200	20200	22.5		
	$5.5x10^{-2}$	8600	20800	26.5		
	$8x10^{1}$	9000	21000	33.3		

Material: Al-6061-T651; Si 0.68, Fe 0.52, Cu 0.25, Mn 0.04, Mg 0.94, Cr 0.24, Ti 0.02, Zn 0.05

room	$1x10^{-4}$	37300	40370	10.0	L-1 Tension	σ_Y=0.2% offset Read from table Instron .0001-.01S^{-1} Hydraulic .0001-10S^{-1} Hopkinson pressure bar 100-1000 S^{-1} Strain rate is determined from relative velocity of two faces
	$1.67x10^{-2}$	40570	34500	18.2		
	$1x10^{-1}$	37500	40900	12.1		
	$9.1x10^{-1}$	40600	42500	22.9		
	$9.2x10^{-1}$	40200	42300	17.9		
	$9.3x10^{-1}$	40300	42200	18.9		
	$6.6x10^{0}$	39700	41900	18.8		

T(°F)	$\dot{\varepsilon}$(/sec)	σ_Y(psi)	σ_U(psi)	Elong.(%)	Ref.	Remarks
	7.6×10^{0}	38000	40400	16.9		
	8.2×10^{0}	39500	42100	12.5		
	3.1×10^{2}	37300	40700	14.3		
	3.3×10^{2}	39200	42300	14.7		
	3.5×10^{2}	39800	42700	14.7		
	4.4×10^{2}	39800	42400	11.2		
	1×10^{3}	39600	41700	15.4		

TABLE 3 - DYNAMIC PROPERTIES OF Al-7075

Material: Al-7075-0; Zn 5.61, Mg 2.50, Cu 1.26, Fe 0.35, Mn 0.05, Ti 0.04, Si 0.02, Ni Trace, Al Bal.

T(°F)	$\dot{\varepsilon}$(/sec)	σ_y(psi)	σ_u(psi)	Elong.(%)	Ref.	Remarks
77	2.5×10^{-5}	14300			D-1 Tension	σ_y = 0.2% offset Specimens were cu from a single hea of 7075-T6 Al. Annealed at 776± 18°F for 2 hrs., cooled to 468°F i 3 hrs. and air cc ed to room temper ture. Constant cross-head speeds Read from (σ_y , $\dot{\varepsilon}$ curves
	5×10^{-5}	14300				
	2.5×10^{-4}	14300				
	5×10^{-4}	14300				
	1.5×10^{-3}	14300				
	2.5×10^{-3}	14400				
	5×10^{-3}	14300				
	1.5×10^{-2}	14400				
	2.5×10^{-2}	14300				
	5×10^{-2}	18000				
	1.5×10^{-1}	20000				
600	2.5×10^{-5}	6150				
	5×10^{-5}	6200				
	2.5×10^{-4}	7300				
	5×10^{-4}	8150				
	1.5×10^{-3}	8700				
	2.5×10^{-3}	8300				
	5×10^{-3}	9300				
	1.5×10^{-2}	10150				
	2.5×10^{-2}	11250				
	1.5×10^{-1}	14300				
	5×10^{-1}	19000				
700	2.5×10^{-5}	4300				
	5×10^{-5}	4600				
	2.5×10^{-4}	5250				
	5×10^{-4}	6000				
	1.5×10^{-3}	6600				
	2.5×10^{-3}	7500				
	5×10^{-3}	8150				
	1.5×10^{-2}	9150				
	2.5×10^{-2}	10150				
	5×10^{-2}	11000				
	5×10^{-1}	[illegible]				

T(°F)	$\dot{\epsilon}$(/sec)	σ_Y(psi)	σ_U(psi)	Elong.(%)	Ref.	Remarks
800	2.5×10^{-5}	3300				
	5×10^{-5}	3700				
	2.5×10^{-4}	4200				
	5×10^{-4}	4600				
	1.5×10^{-3}	5000				
	2.5×10^{-3}	5700				
	5×10^{-3}	6300				
	1.5×10^{-2}	7250				
	2.5×10^{-2}	8700				
	5×10^{-2}	9500				
	1.5×10^{-1}	12000				
	5×10^{-1}	13900				
850	2.5×10^{-5}	2500				
	5×10^{-5}	3300				
	2.5×10^{-4}	3400				
	5×10^{-4}	3650				
	1.5×10^{-3}	4000				
	2.5×10^{-3}	4300				
	5×10^{-3}	4700				
	1.5×10^{-2}	5350				
	2.5×10^{-2}	6400				
	5×10^{-2}	7950				
	1.5×10^{-1}	9150				
	5×10^{-1}	12200				
875	2.5×10^{-5}	2200				
	5×10^{-5}	2900				
	2.5×10^{-4}	3200				
	5×10^{-4}	3600				
	1.5×10^{-3}	3950				
	2.5×10^{-3}	4150				
	5×10^{-3}	4550				
	1.5×10^{-2}	5000				
	2.5×10^{-2}	6150				
	1.5×10^{-1}	9400				
	5×10^{-1}	12000				

(°F)	$\dot{\varepsilon}$(/sec)	σ_Y(psi)	σ_U(psi)	Elong.(%)	Ref.	Remarks
laterial: Al-7075-0; ZN 5.6, Mg 2.5, Cu 1.6, Cr 0.3, Al Bal.						
oom	2.5×10^{-3}	18200			H-6 Comp.	σ_Y = 0.2% offset Read from (σ,ε curves
	6×10^{2}	18600				
laterial: Al-7075-0						
oom	2.7×10^{-5}	19000	46400	15.6	S-3 Tension	Normal strain ra
	5.3×10^{-4}	19500	45100	16.0		Charpy impact te ing machine
	6×10^{-2}	23700	45000	19.0		Read from table
	6.7×10^{1}	24500	46000	18.2		
laterial: Al-5.7% Zn; Zn 5.75, Mg 2.21, Cu 1.31, Si 0.21, Fe 0.30, Mn 0.34, Pb 0.01, Al Bal.						
52	4×10^{-1}	11450	14600		B-1 Comp.	σ_Y = 0.2% offset
	9×10^{0}	16550	20000			≈ 7075 A
	1.01×10^{2}	19450	22620			Read from (σ,ε) curves
	3.11×10^{2}	21250	24650			Solution-Treated for 1 hr. at 870°
42	4×10^{-1}	10270	14040			water-quenched
	9×10^{0}	16000	19600			overaged at 284°F for 16 hrs.,furna
	1.01×10^{2}	19600	22600			cooled to room te perature
	3.11×10^{2}	22270	25940			True stress
32	4×10^{-1}	5500	6600			Natural strain
	9×10^{0}	9000	10600			
	1.01×10^{2}	13100	15200			
	3.11×10^{2}	16100	17500			
022	4×10^{-1}	3820	4640			
	9×10^{0}	6000	7640			
	1.01×10^{2}	9820	11180			
	3.11×10^{2}	12000	12980			
aterial: Al-7075-T6						
oom	0	75400			J-1 Comp.	Read from (σ,ε) urves
	6.6×10^{3}	131000				Solution heat treated and aged
oom	3×10^{-2}	68000			M-1 Comp.	σ_Y = 0.2% offset Read from (σ,ε) curve

'F)	$\dot{\varepsilon}$ (/sec)	σ_Y (psi)	σ_u (psi)	Elong. (%)	Ref.	Remarks
						Medium strain rate machine and split Hopkinson bar apparatus
)m	1.9×10^{-5}	64000	83000	10.2	S-3	Normal strain rate
	3.1×10^{-4}	67000	84700	12.9	Tension	Charpy impact testing
	6×10^{-2}	70000	80000	12.0		Read from table
	4.3×10^{1}	75000	85000	13.0		
	3×10^{-3}	77500	84600		G-1 Tension	
	8×10^{0}	77500	84600			
)	1×10^{-3}	64000	68500			
	8×10^{0}	68000	74000			
)	3×10^{-3}	16500	17500			
	1×10^{1}	28000	28500			

:erial: Al-7075-T6; Cu 1.6, Mg 2.5, Zn 5.6, Cr 0.3, Al Bal.

)m	0	59000			C-4	Strain rate = speed of plastic wave/ gage length
	6×10^{4}	86500	100900	42	Tension	σ_Y = 0.01% offset Read from table Spring-powered impact machine
	5×10^{-5}	60770	75380		K-1	σ_Y = 0.2% offset
	1×10^{0}	67690	72150		Tension	Read from (σ, ε) curves
)	5×10^{-5}	48150	56000			
	1×10^{0}	58460	66150			
)	5×10^{-5}	22070	29230			
	1×10^{0}	29610	34610			
)	5×10^{-5}	5380	9230			
	1×10^{0}	17100	20850			

:erial: Al-7075-T651

	4×10^{-3}	72000			M-2	Read from (σ, ε) curves
)	2×10^{-3}	64500			Comp.	σ_Y = 0.2% offset
)	5×10^{0}	48500				
)	1.2×10^{-2}	12000				
	1×10^{3}	24260				

TABLE 4 - DYNAMIC PROPERTIES OF Al-2014 OR EQUIVALENCE

Material: Al-2014-F; Mn 0.8, Cu 4.4, Si 0.8, Mg 0.4

T(°F)	$\dot{\varepsilon}$(/sec)	σ_Y(psi)	σ_u(psi)	Elong.(%)	Ref.	Remarks
room	0	17000			C-4 Tension	Read from table Strain rate = spee of slowest plastic wave/gage length Spring-powered im- pact machine σ_Y= 0.01% offset
	$6x10^4$	28400				

Material: Al-4.2% Cu; Cu 4.17, Mg 0.89, Si 0.68, Fe 0.41, Mn 0.80, Zn 0.052, Pb 0.01, Al Bal.

T(°F)	$\dot{\varepsilon}$(/sec)	σ_Y(psi)	σ_u(psi)	Elong.(%)	Ref.	Remarks
572	$4x10^{-1}$		15000		B-1 Comp.	Read from (σ, ε) curves True stress Heat-treated for 1/2 hr. at 1112°F Natural strain
	$2x10^0$		17000			
	$9x10^0$		20830			
	$4.1x10^1$		24000			
	$2.03x10^2$		26670			
662	$4x10^{-1}$		12800			
	$9x10^0$		17280			
	$1.01x10^2$		21540			
	$3.11x10^2$		23850			
752	$4x10^{-1}$		10610			
	$9x10^0$		14780			
	$1.01x10^2$		18260			
	$3.11x10^2$		21590			
842	$4x10^{-1}$		8700			
	$9x10^0$		14170			
	$1.01x10^2$		17500			
	$3.11x10^2$		21250			
932	$4x10^{-1}$		6780			
	$9x10^0$		12170			
	$1.01x10^2$		17250			
	$3.11x10^2$		20000			

Material: Al-Cu4-Mg1; Cu 4.6, Mg 1.46, Mn 0.74, Si 0.22, Zn 0.05, Fe 0.1, Al Bal.

T(°F)	$\dot{\varepsilon}$(/sec)	σ_Y(psi)	σ_u(psi)	Elong.(%)	Ref.	Remarks
-103	$1x10^{-3}$	26050	52000	18.5	H-2	Read from (σ_Y, $\dot{\varepsilon}$)

T(°F)	$\dot{\epsilon}$ (/sec)	σ_Y(psi)	σ_u(psi)	Elong. (%)	Ref.	Remarks
	1×10^{-2}	25000	49800	18.0		
	1×10^{-1}		49400			
	1×10^{2}	28400	53300	20		
68	1×10^{-3}	25500	56900	13		
	1×10^{-2}	24900	54000	17.7		
	1×10^{-1}	26200	49800	18.8		
	1×10^{2}	24900	45000	17.7		

Material: HE 15 WP Al ≈ Al-2014-T6

T(°F)	$\dot{\epsilon}$ (/sec)	σ_Y(psi)	σ_u(psi)	Elong. (%)	Ref.	Remarks
room	0	17430			N-3 Torsion	σ_Y = 0.2% offset Read from (σ,ϵ) curves Torsional Hopkinson bar
	5×10^{2}	19000				
	1×10^{3}	19500				

Material: Al-Cu-Si-Mg Alloys ≈ Al-2014; Cu 4.4, Mn 0.8, Mg 0.56, Si 0.9, Fe 0.36, Al Bal.

T(°F)	$\dot{\epsilon}$ (/sec)	σ_Y(psi)	σ_u(psi)	Elong. (%)	Ref.	Remarks
572	1×10^{0}		15400		A-2 Comp.	Read from (σ, ϵ) curve Annealed for 6 hr. at 750°F and furnace-cooled to room temperature Cam plastometer & $\dot{\epsilon}$ was computed by dividing the decrement effected by the initial specimen height & by the associated test period.
	1×10^{1}		16000			
	2×10^{1}		17000			
	3×10^{1}		18000			
752	1×10^{0}		10800			
	1×10^{1}		12800			
	2×10^{1}		14400			
	3×10^{1}		15700			
842	1×10^{0}		9400			
	1×10^{1}		11600			
	2×10^{1}		13200			
	3×10^{1}		14400			

TABLE 5 - DYNAMIC PROPERTIES OF Al-2024

Material: Al-2024-0

T(°F)	$\dot{\epsilon}$ (/sec)	σ_Y(psi)	σ_u(psi)	Elong.(%)	Ref.	Remarks
-320	$1\times10^{-3} \sim 4\times10^{-1}$	25000			F-1 Torsion	σ_Y = 0.2% offset Read from (σ, ϵ) curves Constant strain ra
82	$1\times10^{-3} \sim 4\times10^{-1}$	11900				
390	1×10^{-3}	11000	15400			
	2.67×10^{-3}	11000	16150			
	4×10^{-1}	11000	17700			
660	1×10^{-3}	2850	3150			
	2.67×10^{-3}	3100	3670			
	1.6×10^{-2}	3850	4380			
	6.7×10^{-2}	4540	5310			
	4×10^{-1}	5600	6610			
930	1×10^{-3}	1050	1380			
	2.67×10^{-3}	1230	1620			
	1.67×10^{-2}	1780	2050			
	6.7×10^{-2}	2700	2890			
	4×10^{-1}		3850			

Material: Al-2024-T4

T(°F)	$\dot{\epsilon}$ (/sec)	σ_Y(psi)	σ_u(psi)	Elong.(%)	Ref.	Remarks
room	1.7×10^{-4}	54000	84400		S-2 Tension	Read from (σ, ϵ) curves
	1.92×10^{2}	54000	86500			

Material: Al-2024-T4; Mn 1.5, Cu 4.5, Mg 0.6, Al Bal.

T(°F)	$\dot{\epsilon}$ (/sec)	σ_Y(psi)	σ_u(psi)	Elong.(%)	Ref.	Remarks
room	0	41000			C-4 Tension	Read from table Strain rate = spee of plastic wave/ gage length σ_Y= 0.01% offset Spring-powered impact machine
	6×10^{4}	54800				

Material: Al-2024

T(°F)	$\dot{\epsilon}$ (/sec)	σ_Y(psi)	σ_u(psi)	Elong.(%)	Ref.	Remarks
200	0		28000		S-4 Tension	Annealed 600°F for 3 min.
	$10^{2} \sim 10^{3}$		20000			
450	0		14500			
	$10^{2} \sim 10^{3}$		20500			

T(°F)	$\dot{\epsilon}$(/sec)	σ_Y(psi)	σ_U(psi)	Elong.(%)	Ref.	Remarks
600	0		6000			
	10^2–10^3		20800			

TABLE 6 - DYNAMIC PROPERTIES OF OTHER Al-ALLOYS

terial: Al-2017; Si 0.83, Fe 1.00, Cu 4.18, Mn 0.46, Mg 0.30, Cr 0.10, Zn 0.25, Ti $<$ 0.01, Al Bal.

°F)	$\dot{\varepsilon}$(/sec)	σ_Y(psi)	σ_u(psi)	Elong.(%)	Ref.	Remarks
2	1×10^{-2}		31250		B-3 Torsion	2 hrs. at 752°F then furnace cooled at 54°F/hr. to 500°F and air cooled to ambient temperature Read from (σ, ε) curves Effective stress & strain & strain rate
	1×10^{-1}		33750			
	1.3×10^{0}		37500			
	8×10^{0}		40000			
	1×10^{2}		41900			
2	1×10^{-2}		10000			
	1×10^{-1}		12810			
	1.3×10^{0}		19700			
	8×10^{0}		21250			
	1×10^{2}		24250			
2	1×10^{-2}		7500			
	1×10^{-1}		9250			
	1.3×10^{0}		12050			
	8×10^{0}		15100			
	1×10^{2}		17800			
2	1×10^{-2}		5750			
	1×10^{-1}		7170			
	1.3×10^{0}		9850			
	8×10^{0}		12420			
	1×10^{2}		15250			
2	1×10^{-2}		4000			
	1×10^{-1}		5650			
	1.3×10^{0}		8050			
	8×10^{0}		11000			
	1×10^{2}		13850			
2	1×10^{-2}		2750			
	1×10^{-1}		4050			
	1.3×10^{0}		6500			
	8×10^{0}		9200			
	1×10^{2}		12000			

terial: 24S-T Al; Cu 4.5, Mn 0.6, Mg 1.5, Al Bal.

(°F)	$\dot{\varepsilon}$ (/sec)	σ_Y (psi)	σ_u (psi)	Elong. (%)	Ref.	Remarks
oom	0	46000	65600	20.0	C-2 Tension	Strain rate = speed /gage length
	1.2×10^{2}	56000	73000	20.2		
	4.44×10^{2}	67100	77800	22.3		
	7.68×10^{2}	75000	81800	23.5		
	1.07×10^{3}	71300	76100	22.0		
	1.4×10^{3}	79600	78000	24.8		
	1.78×10^{3}	84800	78000	25.0		

aterial: 24S Annealed Al; Mg 1.55, Cu 4.59, Mn 0.64, Si 0.20, Al Bal.

oom	0		33950	6.7	C-3 Tension	Annealed 675°F, 20 min., cooled in furnace at rate of 25°F/hr.
	3.75×10^{1} – $\sim3\times10^{2}$		44980	9.9		

aterial: 17S-T Al; Cu 4.5, Mn 0.6, Mg 1.5, Al Bal.

oom	0	40000	55400	21.2	C-2 Tension	Strain rate = speed /gage length
	1.8×10^{2}	43700	56350	23.3		
	5.4×10^{2}	37100	60330	25.1		
	9.6×10^{2}	66000	53570	27.8		
	1.44×10^{3}	72400	57500	29.2		
	1.8×10^{3}	61330	57930	29.2		

aterial: 17S-T Al; Mg 0.25, Cu 4.20, Si 0.13, Al Bal.

oom	0		57900	14.2	C-3 Tension	
	3.75×10^{1} – $\sim3\times10^{2}$		63800	17.0		

aterial: Al-5154-0

oom	4.1×10^{-5}	19300	35400	19.7	S-3 Tension	Normal strain rate
	5.1×10^{-4}	19500	35200	24.4		Charpy impact testing machine
	5.3×10^{-2}	22600	34000	23.0		Read from table
	4×10^{1}	22800	35000	27.0		

aterial: Al-5454-0; Si 0.08, Fe 0.22, Cu 0.03, Mn 0.68, Mg 2.56, Cr 0.08, Ti 0.01, Al Bal.

oom	1×10^{-4}	17000	34800	17.0	L-1	σ_Y = 0.2% offset

T(°F)	$\dot{\varepsilon}$(/sec)	σ_Y(psi)	σ_u(psi)	Elong.(%)	Ref.	Remarks
	1.1×10^{-4}	17700	35100	18.2	Tension	Read from table Instron .0001~ .01 S^{-1} Hydraulic .0001~ 10 S^{-1} Hopkinson pressu bar 100~1000 S^{-1} Strain rate is d mined from relat velocity of two faces
	1.54×10^{-4}	16600	33600	16.8		
	1.66×10^{-4}	18030	37230	21.2		
	1×10^{-2}	17900	33700	22.8		
	1.03×10^{-2}	17700	33400	23.5		
	1.66×10^{-2}	16970	35200	27.9		
	3.5×10^{-2}	17100	33400	19.6		
	9.8×10^{-1}	19600	32900	20.4		
	1×10^{0}	18200	33150	19.8		
	1×10^{1}	18870	33130	25.3		
	1.3×10^{2}	17600				
	1.5×10^{2}	18300				
	9.2×10^{2}	22200	35200	36.4		
	9.6×10^{2}	23000	35200	35.8		
	9.8×10^{2}	23200	37500	36.6		

Material: Al-5454-H34; Si 0.08, Fe 0.22, Cu 0.03, Mn 0.68, Mg 2.56, Cr 0.08, Ti 0.01, Al Bal.

room	9.9×10^{-5}	36200	42400	11.3	L-1 Tension	σ_Y= 0.2% offset Read from table Instron .0001~.01 S^{-1} Hydraulic .0001~ 10 S^{-1} Hopkinson pressur bar 100~1000 S^{-1} Strain rate is determined from r lative velocity o two faces
	1.01×10^{-4}	36100	42400	13.8		
	1.6×10^{-4}	34400	41200	9.6		
	1.66×10^{-4}	39000	44530	11.9		
	9.7×10^{-3}	34400	39600	12.6		
	9.9×10^{-3}	34800	39900	11.0		
	1.66×10^{-2}	37550	43700	11.8		
	3.5×10^{-2}	35600	40100	9.8		
	1×10^{0}	35970	40700	14.9		
	1×10^{1}	35800	40700	15.6		
	3×10^{2}	36370	35530			
	1.02×10^{3}	39130	43100	24.2		

Material: Al-2 1/4% Mg Alloy (≈5450); Cu 0.06, Mn 0.17, Mg 2.35, Si 0.22, Fe 0.32, Al Bal.

572	1×10^{0}		20800		A-2 Comp.	Annealed for ~6 hr at 750°F & cooled in air to room tem perature.
	1×10^{1}		21600			
	2×10^{1}		22400			

(°F)	$\dot{\epsilon}$(/sec)	σ_Y(psi)	σ_U(psi)	Elong.(%)	Ref.	Remarks
	$3x10^1$		23000			Read from (σ, ϵ) curves
52	$1x10^0$		11200			Cam Plastometer, $\dot{\epsilon}$ was computed by dividing the decrement effected by the initial specimen height & by the associated test period
	$1x10^1$		13800			
	$2x10^1$		14600			
	$3x10^1$		15200			
32	$1x10^0$		6600			
	$1x10^1$		8600			
	$2x10^1$		9600			
	$3x10^1$		10200			

aterial: Al-5% Mg Alloy ($\approx$5450); Cu 0.10, Mn 0.19, Mg 5.11, Si 0.21, Fe 0.29, Al Bal.

72	$1x10^0$		28200		A-2 Comp.	Annealed for -6 hrs. at 750°F & furnace cooled to room temperature. Read from (σ, ϵ) curves
	$1x10^1$		29200			
	$2x10^1$		30400			
	$3x10^1$		31800			
52	$1x10^0$		19000			Cam Plastometer, $\dot{\epsilon}$ was computed by dividing the decrement effected by the initial specimen height & by the associated test period.
	$1x10^1$		20000			
	$2x10^1$		21200			
	$3x10^1$		22900			
32	$1x10^0$		9600			
	$1x10^1$		12000			
	$2x10^1$		13800			
	$3x10^1$		14800			

laterial: Al-5456-0

oom	$3.1x10^{-5}$	22200	48000	16.9	S-3 Tension	Normal strain rate Charpy impact testing machine Read from table
	$3.8x10^{-4}$	22600	48200	18.2		
	$4.6x10^{-2}$	22000	47000	17.8		
	$7x10^1$	22500	42500	21.0		

laterial: Al-5456-H321

oom	$1.7x10^{-4}$	33000	57200	11.0	S-2 Tension	True stress & Strai
	$1.92x10^2$	33700	65000	17.0		

Material: Al-5456-H343

T(°F)	$\dot{\varepsilon}$(/sec)	σ_Y(psi)	σ_U(psi)	Elong.(%)	Ref.	Remarks
room	1.7×10^{-4}	50000	62730	11.9	S-2 Tension	True stress & st
	1.92×10^{2}	56970	72730	9.3		

Material: Al-6351-T51; Si 0.94, Fe 0.32, Cu 0.07, Mn 0.65, Mg 0.58, Cr 0.01, Ti 0.05, Zn 0.03, Al Bal.

T(°F)	$\dot{\varepsilon}$(/sec)	σ_Y(psi)	σ_U(psi)	Elong.(%)	Ref.	Remarks
room	1×10^{-4}	44130	46330	7.06	L-1 Tension	σ_Y = 0.2% offset
	1.7×10^{-4}	51330	53030	15.0		Read from table
	1×10^{-2}	45800	47800	7.7		Instron .0001~.0 S^{-1}
	3.7×10^{-1}	48900	50300	9.68		Hydraulic .0001~ 10 S^{-1}
	9.1×10^{-1}	48800	50500	13.1		Hopkinson pressu
	9.5×10^{-1}	46700	48600	13.1		bar 100~1000 S^{-1}
	7.3×10^{0}	47000	49200	7.4		Strain rate is d
	1.01×10^{1}	48300	49900	7.06		termined from re
	1.16×10^{1}	49100	50900	9.18		tive velocity of two faces
	1×10^{2}	49600	51400			
	3.6×10^{2}	47700	50600	10.5		
	1×10^{3}	51100	51800	11.0		

Material: Al-Si-Mg Alloy (≈6354); Cu 0.07, Mn 0.53, Mg 0.73, Si 1.04, Fe 0.36, Al Bal.

T(°F)	$\dot{\varepsilon}$(/sec)	σ_Y(psi)	σ_U(psi)	Elong.(%)	Ref.	Remarks
572	1×10^{0}		9600		A-2 Comp.	Read from (σ, ε curves
	1×10^{1}		11200			Annealed for ~6
	2×10^{1}		12200			at 750°F & furna
	3×10^{1}		12600			cooled to room t perature.
752	1×10^{0}		7000			Cam Plastometer
	1×10^{1}		9000			$\dot{\varepsilon}$ was computed b
	2×10^{1}		10000			dividing the dec ment effected by
	3×10^{1}		10800			initial specimen
932	1×10^{0}		4900			height & by the associated test
	1×10^{1}		6600			period.
	2×10^{1}		7300			
	3×10^{1}		7500			
1022	1×10^{0}		3200			
	1×10^{1}		4900			
	2×10^{1}		5600			
	3×10^{1}		5900			

T(°F)	$\dot{\varepsilon}$(/sec)	σ_Y(psi)	σ_u(psi)	Elong.(%)	Ref.	Remarks
Material: Al-7178-T651						
room	1.7×10^{-4}	87500	100000		S-2 Tension	Read from (σ, ε) curves
	1.92×10^{2}	106000	150000			
Material: Al-7178-T6						
room	1.7×10^{-4}	87500	101200		S-2 Tension	Read from (σ, ε) curves
	1.92×10^{2}	100000	138500			
Material: Al-RR77						
room	1×10^{-3}	80000		7.9	H-1 Tension	σ_Y = 0.2% offset Constant true str rate
	8×10^{2}	114200		11.7		Impact machine
	1.75×10^{3}	122000		12.9		Read from table
Material: Al-Mn Alloy ($\approx$3003); Cu 0.04, Mn 1.36, Si 0.30, Fe 0.33						
572	1×10^{0}		10000		A-2 Comp.	Read from (σ, ε) curves Annealed for ~6 h at 930°F & cooled in air to room te perature Cam Plastometer $\dot{\varepsilon}$ was computed by dividing the decr ment effected by the initial speci men height & by t associated test period
	1×10^{1}		11000			
	2×10^{1}		11800			
	3×10^{1}		12400			
752	1×10^{0}		6200			
	1×10^{1}		7400			
	2×10^{1}		8000			
	3×10^{1}		8400			
932	1×10^{0}		5200			
	1×10^{1}		5700			
	2×10^{1}		6200			
	3×10^{1}		6900			
1022	1×10^{0}		3700			
	1×10^{1}		4500			
	2×10^{1}		5000			
	3×10^{1}		5200			

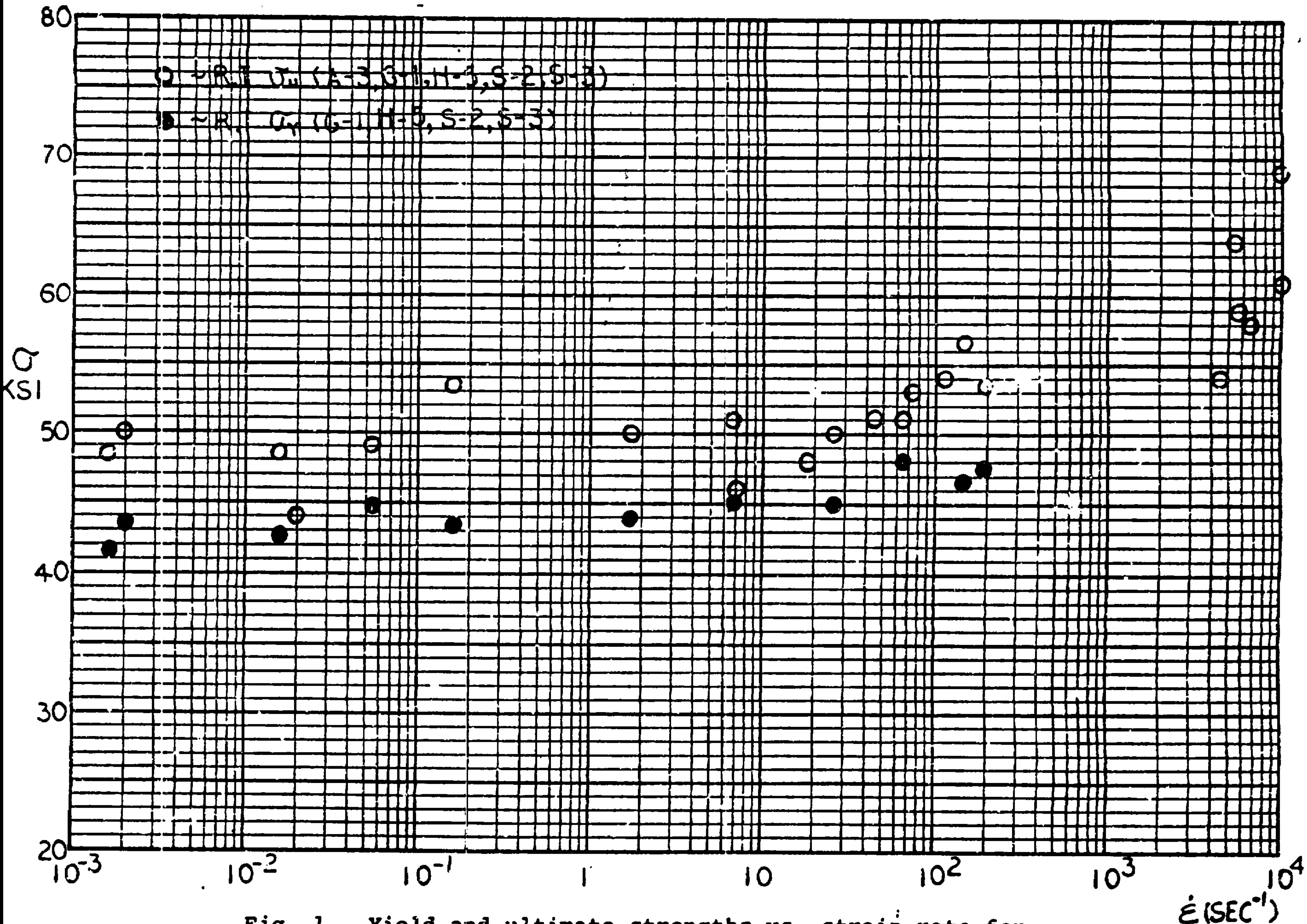

Fig. 1 Yield and ultimate strengths vs. strain rate for

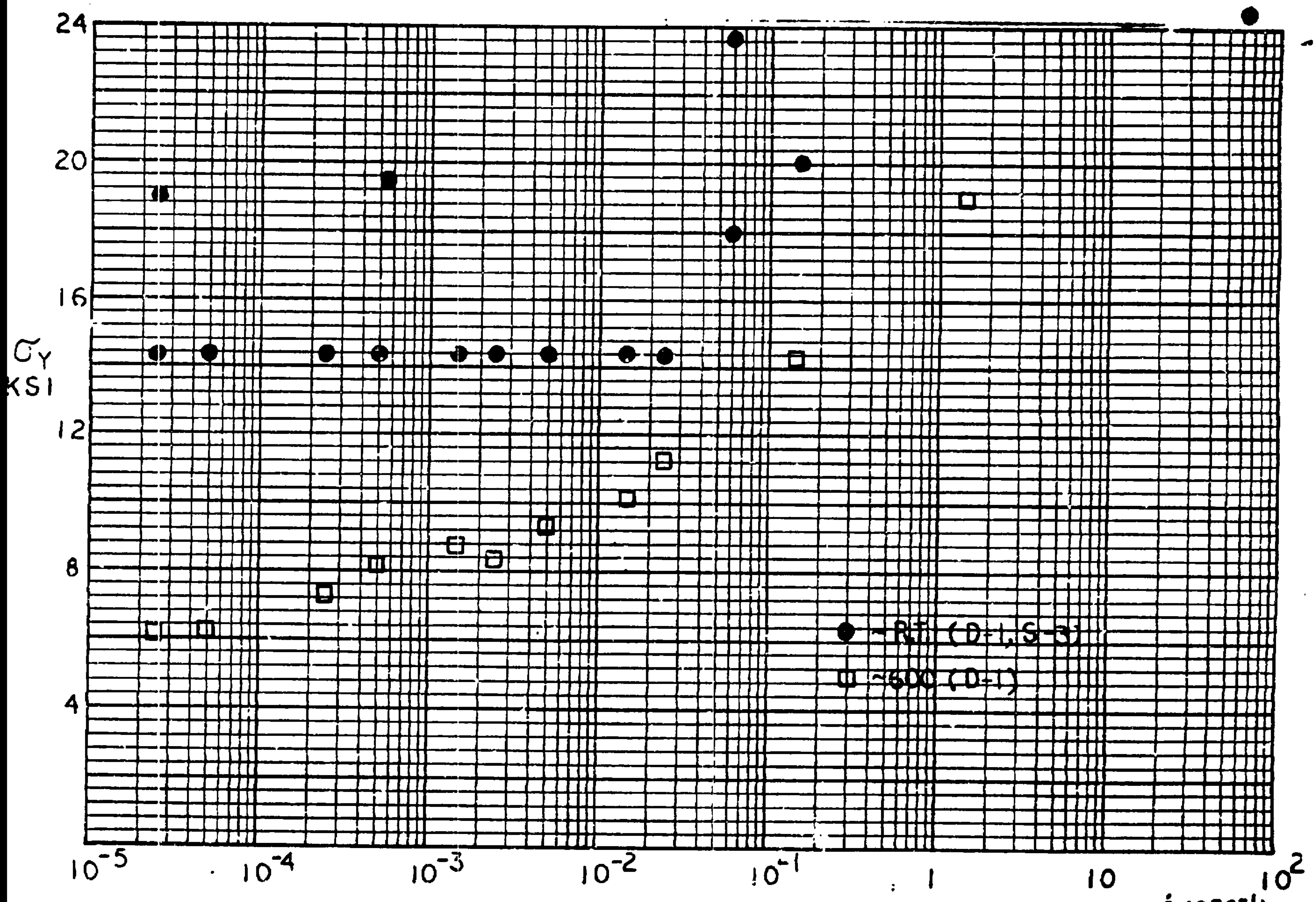

Fig. 2 Yield strength vs. strain rate for Al-7075-0

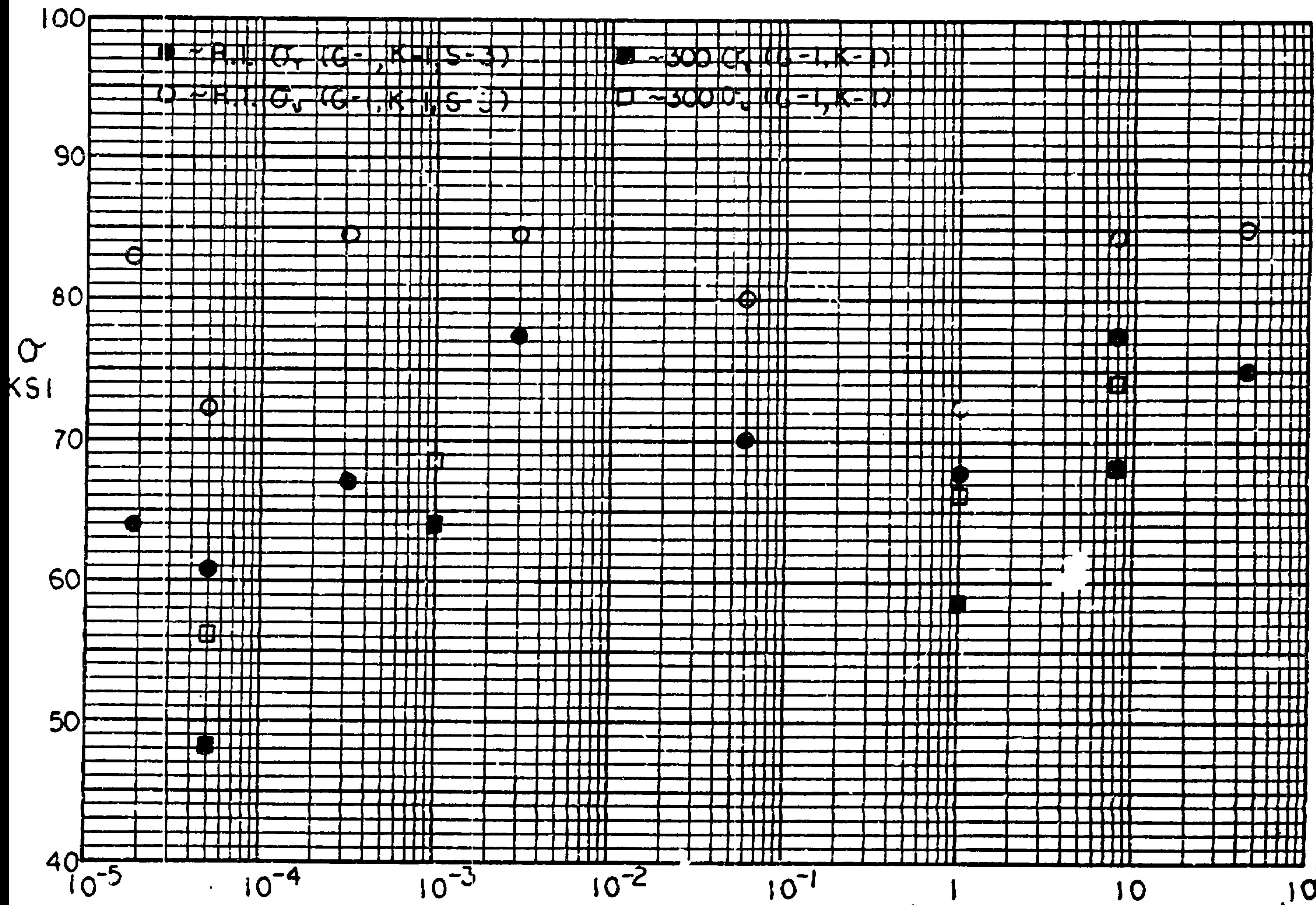

Fig. 3 Yield and ultimate strengths vs. strain rate for Al-7075-T6 in tension

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